Chapter 7. Use of cylindrical delay regions

A system has been developed for specifying station delays within arbitrarily shaped regions. The strategy for specifying the regions and allowing for smooth transitions on the edges of the regions was suggested by Fred Klein and extended to allow for variations with depth. A region is modeled by one or a combination of vertical cylinders (Figure 7-1), each of which is specified by the coordinates (including depth) of its center, an inner height and an inner radius within which stations delays specific to that region will be used, and an outer height and an outer radius within which station delays will be based on a combination of delay models for this region and adjacent regions.

For each trial location during the earthquake location process, the horizontal and vertical distance to the center of each cylindrical regional is computed. There are three fundamentally different cases to consider:

(Case 1) The location falls within the inner cylinder of one or more of the regions -- in which case the delays specified for the region with the smaller volume are used. If volumes are equal, parameters for the volume with center closest to the epicenter are used.

(Case 2) The location falls outside the outer cylinder of every region -- in which case the default delays are used.

(Case 3) The location falls within the transition zone of one or more of the regions. In this case a three-step procedure is followed:

> Step One - A table of weights is generated with one entry for each transitional region that the location falls within. Each entry consists of the delay-model number preferred by the region and the weight, which is computed based on a cosine function that tapers from one at the edge of the inner cylinder to zero at the outer cylinder. Near the corners of each cylinder an elliptical function is used to determine the weight (Figure 7-1). For example, a table with for a location that falls within three transitional regions might be:

Delay Model	Weight
2	.15
4	.40
2	.20

Step Two - If a given delay model appears more than once, then a new combined entry is formed with the sum of the weights for that model. The example table above would become

Delay Model	Weight
2	.35
4	.40

Step Three - The resulting table is sorted by weight, which for this example would result in:

Delay Model	Weight
4	.40
2	.35

Three possibilities must be considered in assigning the final delays:

(a) There is only one entry in the table. If the weight is greater than or equal one, then this delay model is used. Otherwise, the default model is given sufficient weight to bring the total weight up to one, and weighted-average delays are computed for each station.

(b) There are two entries in the table. If the sum of the weights is greater than or equal to one, then the weighted-average delays are computed from these two delay models. If the sum of the weights is less than one, then the default delay-model is given sufficient weight to bring the total up to one, and weighted average delays are computed from the default model combined with the other two models.

(c) There are three or more entries in the table. The weighted-average delays are computed from the three models with the highest weight.

The cylindrical regions are defined in a free-format file, whose name is specified after the SELECT DELAY record (see 2.2.3.6). Each line defines one cylinder, as follows:

Delay Model #	Velocity Model #	Lat (N Pos)	Lon (W Pos)	Inner Radius	Outer Radius	Inner Top-Depth	Outer Top-Depth	Inner Bottom-Depth	Outer Bottom-Depth
integer	integer	real	real	real	real	real	real	real	real
For example:									
2	3	60.0	150.5	100.	150.	0.0	0.0	50.	80.

Lines beginning with C* are ignored and may be used for comments. Up to 10 delay models may be used with this option. Delay model # 1 is the default model, as defined above. Models #' 1-5 are read from the station list (see 2.2.5.2), while models # 6-10 are read in sets following the station list, as described in 2.2.5.5.

The velocity model may also be set by this option. If an event is within one or more of the inner cylindrical regions, then the velocity of the region for which the earthquake is closest to the cylinder's center will be used.

$$W(P_1) = \frac{1}{2} \cos\left(PI \frac{X}{a}\right) + \frac{1}{2}$$

$$W(P_2) = \frac{1}{2} \cos\left(PI \sqrt{\frac{X^2}{a^2} + \frac{Y^2}{b^2}}\right) + \frac{1}{2}$$
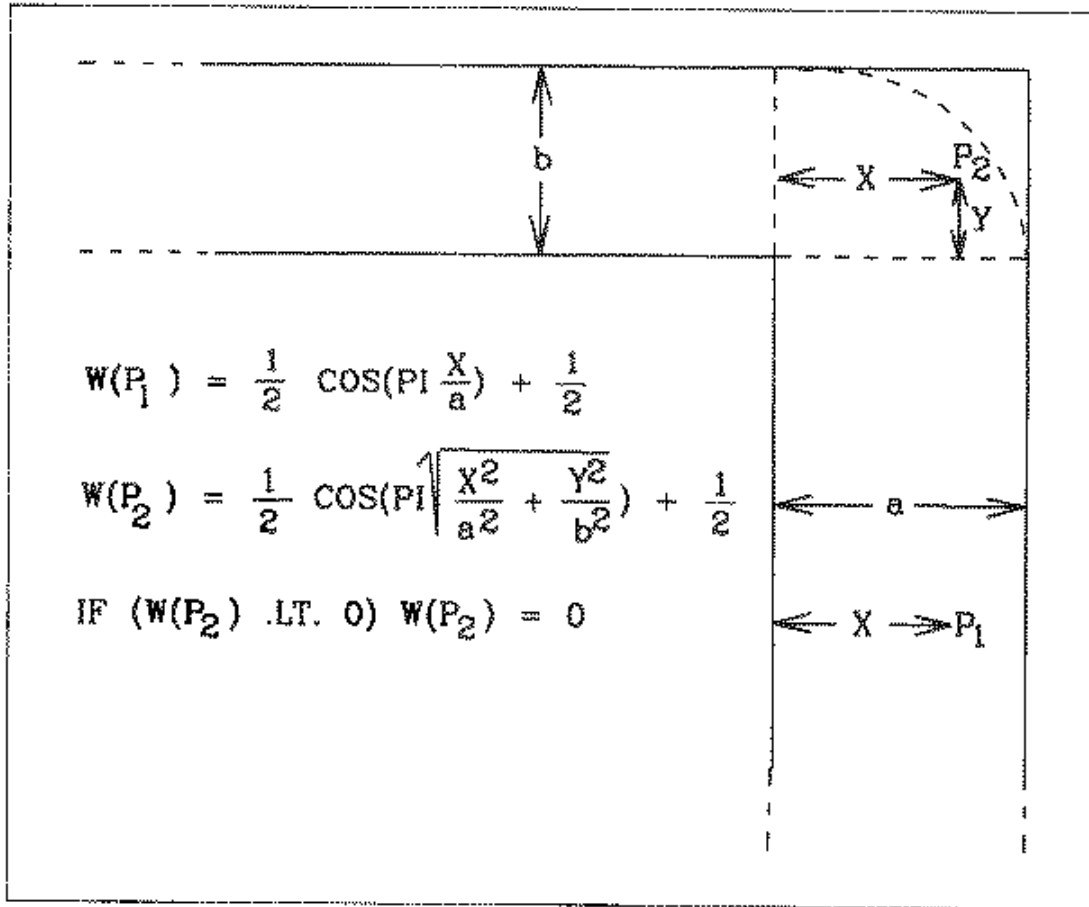
$$\text{IF } (W(P_2) \text{ .LT. } 0)\ W(P_2) = 0$$

Figure 7-1 A vertical cross-section through the upper-right portion of a cylindrical domain illustrating how weights are computed for points along the edges (e.g. P_1) and for points within the corner regions (e.g. P_2).